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ORIGINAL ARTICLES.

I.—ON THE TRIPARTITE CLASSIFICATION OF THE LOWER PALÆOZOIC ROCKS.

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BY those accustomed to the hopeless confusion of the *Greywacké* of the earlier geologists, the publication of Murchison's grand work on the "Silurian System" was hailed with feelings of the most profound relief and satisfaction. His clear and brilliant presentation of the physical and palæontological proofs of an orderly sequence among the Palæozoic Rocks below the Old Red Sandstone, as originally set forth in all their force and harmony in his magnificent volumes, naturally astonished and dazzled the majority of his scientific contemporaries, and secured for his nomenclature of these ancient deposits an almost universal acceptance. His subsequent abuse of this advantage to strengthen and consolidate his own system at the expense of that of his equally-illustrious co-worker—the less fortunate but more cautious Sedgwick—was a gallant but unscrupulous defence of this original nomenclature, which by that time he must have felt himself almost powerless to disturb. His later extension downward of the limits of his System, till it embraced all the rocks between the supposed Azoics and the Old Red Sandstone—though, in a measure, forced upon him from without—ought perhaps to be regarded in part as a very natural return to the ideas of his early teachers, who had always held the practical unity of the rocks of the *Transitional* period. In this way, however, Murchison unwittingly destroyed many of the most beneficial results of his own labours; in a sense, spending his old age in the attempted re-erection of the very edifice it had been the pride of his manhood to destroy—the early years of his scientific career being devoted to the worthy task of proving the marvellous variety of the Lower Palæozoics; his later years to demonstrating their integrity, unity, and indivisibility.

At the present day it would be wholly superfluous to enter upon the discussion of the vexed question of the respective claims of Sedgwick and Murchison to the *Middle* and *Lowest* Divisions of the Lower Palæozoic Rocks. We may, however, without fear of contradiction, concede to Sedgwick the credit of having been the first to

determine the limits and sequence of their larger subdivisions, and to Murchison and his followers the honour of having been the first to assign them their distinctive fossils. Sedgwick worked out single-handed the true stratigraphical arrangement of the rocks of the Lower Palæozoics of Wales, from the Bangor Beds to the summit of the Bala Series, and divided them into several successive groups, the propriety and convenience of which subsequent research has served only to make more distinctly apparent. The unavoidable—but none the less vital—defect in his earlier work lay in his not publishing the characteristic fossils of these subdivisions, until after the appearance of the great work of his rival, in which the most conspicuous forms appear as characteristic of the subdivisions of a supposed overlying system. Murchison's work, on the other hand, depended not only upon mineralogical characters and sequence of formations, but also upon palæontological peculiarities. He failed signally, however, in strictly and correctly defining his lower groups, and in correlating some of his most typical beds, with the result of greatly confusing his lists of characteristic fossils.

The rigid conservatism of Murchison in his old age, and his systematic disregard of the facts and arguments adduced in support of the Cambrian System, brought about its inevitable re-action after his death. The campaign against the Murchisonian nomenclature, so brilliantly opened by Professor Sterry Hunt, in his masterly paper on the “History of the Names Cambrian and Silurian in Geology,” has since assumed extraordinary proportions. The Cambridge School, headed by Professor Hughes, the present talented occupant of the Woodwardian Chair, supported by several earnest and industrious adherents, has revived the claims of Sedgwick in all their entirety; and presses them on the attention of geologists with an energy and persistence that threatens to lead to the formation of a body of workers, determined to force from posterity, in honour of the memory of Sedgwick, the rights he demanded, but of which during his lifetime he was so unfairly deprived.

But, on the other hand, the Murchisonian nomenclature is embodied in the maps and publications of the National Survey. It is embalmed in the classic memoirs of the illustrious Barrande, and in the numerous works of the best-known geologists of Europe and America. It is still held, almost in its widest sense, by the more influential officers of the Geological Survey, and is taught to their students and subordinates with that complacent pride which has naturally been engendered by a quarter of a century of uninterrupted success. Even yet, its advocates have such an unfaltering faith in its intrinsic propriety and consequent impregnability, that the fact of the daily increasing number and ability of their opponents is either contemptuously ignored, or, at most, is deemed unworthy of a more respectful recognition than a passing smile.

The utter impossibility of reconciling the antagonistic claims of these opposing schools has led, of late years, to the formation of a third party, in which the best-known names are those of the late Sir Charles Lyell, and of Dr. Henry Hicks. These concede the

light of Murchison to all the strata between the base of the Arenig and the summit of the Ludlow, but emphatically assign the Lingula Flags and Paradoxides Beds to the Cambrian. This school—if school it may be called—has been greatly aided by the wide publicity given to their views in the numerous memoirs in which they record their steady and cautious advance in working out the natural succession among the subordinate members of the Lower Palæozoic Rocks. It is just possible that, owing to the modesty of the claims it makes for Sedgwick, and to its retention of such a large proportion of the prevalent nomenclature, this view might gradually and insensibly have taken possession of much of the field, were it not for the persistent exertions of the Cambridge School, smarting under a sense of injustice, and determined to rest satisfied with nothing less than a complete redress of those historic grievances, which their affection for the honoured name of Sedgwick has led them to regard as little less than personal to themselves.

But the partial success that has already attended the earnest conscientiousness and perseverance of the members of the Sedgwickian party has, in truth, hastened the evil day. The result that their efforts have had in calling the attention of geologists to the salient points of the question at issue, is as fatal in its effects upon their own theory, as it is upon that of their opponents. By their recent adoption of the Lyell-Hicks line of demarcation at the base of the Lower Llandovery, they furnish, indeed, a thorough demonstration of the almost perfect palæontological distinctness of the faunas of the so-called *Lower Silurian* formations, and those of the true or Upper Silurian, and the consequent impossibility of combining them philosophically in one and the same system. But, in spite of all that is implied to the contrary, this course is, in effect, a distinct abandonment of Sedgwick's fundamental argument that these systems were necessarily distinct, from the fact that in the typical areas their beds were stratigraphically discordant. It amounts, on the other hand, to an implicit adoption of the only safe principle, that we have no reliable chronological scale in geology but such as is afforded by the relative magnitude of zoological change—in other words, that the geological duration and importance of any system is in strict proportion to the comparative magnitude and distinctness of its collective fauna. It appears to me that it is impossible for them to rest here, but that their next and inevitable step will be the further admission that the Lyell-Hicks division of *Cambrian* and *Lower Silurian* are as rightly entitled to the rank of separate systems as the true or *Upper Silurian* itself; and that, eventually, their rigid sense of fairness and justice will lead them so to discriminate them.

For, amid all the confusion incident to this controversy, one grand fact stands out clear and patent to the most superficial student of Palæozoic geology—namely:—the strata included between the horizon marking the advent of *Paradoxides*, and the provisional line presently drawn at the summit of the Ludlow, imbed *three distinct faunas*, as broadly marked in their characteristic features as any of those typical of the accepted systems of a later age.

The necessity for a tripartite grouping of the Lower Palæozoic Rocks and Fossils, in partial accordance with this fact, has been very generally acknowledged for the last thirty years. The keen-eyed and philosophic Barrande was the first to recognize this truth, and his addition of the "*Primordial*" to the *First* and *Second* Faunas of Murchison's original Silurian marked a geologic era equal in importance to the establishment of a new system. How keenly its enthusiastic discoverer watched over, and how zealously he promoted and encouraged, the gradual detection and elimination of his "*Primordial*" Fauna in Europe and America, are matters familiar and delightful to all earnest students of the history of discovery among the Lower Palæozoic Rocks. How the facts obtained by Phillips, Salter, and Hicks in Britain, forced even Murchison himself to adopt Barrande's views, and in his later years to become their keenest and most unsparing advocate, is equally well known. The subsequent development of the "*Primordial*" Fauna in Britain by Hicks, Salter, Belt, and others; in Sweden by Angelin, Nathorst Linnarsson, and Sjögren; and in America by Billings, Emmons, Hall, and Hartt, has progressed with marvellous rapidity. Every systematic geologist worthy of the name has, in his turn, been compelled to acknowledge the distinctness and first-rate importance of the "*Primordial*" Fauna.

Under one form or another, also, the difference in the facies of the more recent *First* and *Second* Faunas of Murchison has been universally admitted from the first, and the rock-groups formed by their including strata have been separated—at least as distinct *sub-systems*—in all parts of the world. It is indeed true that there have been, perhaps, as many diverse views held with respect to the proper position of the line of demarcation between them, as there have been separate areas of investigation; and it is only of late that geologists have reached something like a consensus of opinion in drawing it with Hicks at the base of the Lower Llandovery. Nevertheless, no honest investigator, either British or foreign, has ever dreamt of disputing the grand fact of the distinctness of these two faunas and the consequent need for the separation of their containing rock-groups in any natural and workable plan of classification.

Thus, it is hardly possible that any geologist, who is familiar with the rocks and fossils of the Lower Palæozoics, or who is even fairly versed in the literature of the subject, would at present venture to deny the proposition that between the base of the known fossiliferous series and that of the Old Red Sandstone there lie three successive rock-groups—each of which is characterized by a special fauna of first-rate geologic importance.

Further insistence upon this point is probably needless. But if the fact be once admitted, it follows of necessity that the interests of science demand that these three successive rock-systems shall be distinguished by three separate and unmistakable titles.

At this stage, however, we plunge into the very midst of the conflict of the schools. Friends, foes, and spectators, seem all fairly agreed as to the advisability of a triple division of the sediments.

The points around which the strife is at its keenest bear upon the question as to whether these three divisions are of equal classificatory value, and if so, which party has the best right to give them their names.

The strict Murchisonian of the present day claims for the Silurian all the fossiliferous strata that lie between the Archean and the Devonian, and arranges them in his three sub-systems of the *Primordial*, *Lower*, and *Upper Silurian*. If he is a palæontologist, he seizes at once upon the indisputable fact that the general facies of the fossils of these three divisions, when viewed in their collective aspect, has a marked character of its own, wholly distinct from that of the faunas of the overlying rock-groups. Profoundly impressed by this distinction, the less striking differences between the faunas of the three members of the Lower Palæozoic itself dwindle in his eyes into utter insignificance, and the slightest party bias is sufficient to lead him to regard them with Barrande as forming "one grand and indivisible triad which is the *Silurian System*." As discovery progresses, gradually demonstrating the former presence of organic existences in strata far below the base-line laid down by the founder of his system, departing gradually in facies from his typical fauna (but, nevertheless, connected therewith by almost imperceptible gradations), his former admission, and the traditions of his school, compel him to keep pace with it, extending his system and fauna downwards step by step. The result is, that if he is consistent, he is at last driven to demand also, with Barrande, the inclusion of the beds which Murchison, even in his latest years, acknowledged to be the very basement rocks of a *pre-Silurian* system.

If, on the other hand, he is a stratigraphist, he instances the fact that in Britain and America no general stratigraphical discordance interrupts the vertical succession of formations between the Archean and the Carboniferous. He points to the Llandovery beds of Britain, and shows that the grandest stratigraphical break in the entire series in the typical area occurs in the heart of a group of beds that the founder of his school placed partly in one sub-system and partly in the other; but which he, in common with all scrupulous geologists, included in a single formation, whose essential unity he fearlessly challenges his opponents to deny. He calls attention to the *Colonies* of Bohemia to show that even where the palæontological distinction between the sub-systems is most abrupt, yet, according to the greatest of Silurian palæontologists, there is actually an alternation of the two faunas in the beds of passage. Or, he points triumphantly to the succession in Scandinavia, where the Lower Palæozoics are reduced to a collective thickness of a few hundreds of feet, and are occasionally folded up and entangled almost inextricably together in a single section, and asks how is it possible to doubt the unity of a System whose members are individually of such insignificant dimensions, and, physically, are so indissolubly united!

The moving principle of the Sedgwickian, on the contrary, is the demand for historic justice. With true British instinct, he recognizes

the fact that the revered founder of his school was unfairly deprived of the natural fruits of the labours of a lifetime by the overwhelming forces of influence and circumstance; and he chivalrously devotes all his energies to the task of overturning history to the extent of bringing back matters to the point they would have reached, had the relative position of Sedgwick and Murchison been reversed. To this paramount consideration everything else is sacrificed. The Silurian is cut down so as to include the Upper Division only of Murchison's original System; while all the fossiliferous beds below are assigned to the Cambrian. That in this way he commits precisely the same scientific error as the Murchisonian, never seems to occur to his imagination. That every fact adduced in support of Sedgwick's claim to the rocks of the *Second fauna* can be met by one in Murchison's favour equally cogent, is forgotten. That every error committed by the latter to the destruction of his claims can be paralleled by one equally fatal to those of his opponent, is similarly ignored. He has long since convinced himself of the fact that the Silurian, as he restricts it, is quite large enough to form a system by itself, and that its fauna is grand enough and special enough to characterize one; but we never find him carry out this argument to its legitimate conclusion—that, if so, his own Cambrian is not *one*, but *two* systems, whose individuality he is, by his own principles, equally compelled to recognize. He seeks in all kinds of out-of-the-way spots for evidences of local unconformities between the *Balas* and the *Llandovery* to satisfy his stratigraphical conscience that there is sometimes an actual physical break between them; when, without leaving his closet, he could assure himself of the fact that the two systems of the so-called Lower and Upper Silurian are already known to be stratigraphically concordant nearly all over the world. Where this argument fails, we find him insisting upon the presence of conglomerates and upon the sudden change in the character of the organic remains. But each and all the principles of classification implied in these distinctions are violated in his own procedure. The grandest zoological breaks in the whole Lower Palæozoic Series (those between the *Olenus* beds and the *Arenigs* of Britain, and between the *Canadian* and *Trentonian* of North America), and the thickest and most persistent conglomerates that antedate those of the Old Red Sandstone (viz. those of the *Lower Girvan* and *Quebec Groups*), all occur in the very heart of his own Cambrian System. Yet of these we hear little or nothing, but all the strata between the Archean and the Llandovery are piled up into a single system, for the sole reason that they happen to occur in association in the mountain-area of North Wales, and were very naturally lumped together by the first scientific man who conscientiously studied them.

The Lyellian is certainly more politic than his excited neighbours, but, from a common-sense point of view, his disinterested procedure is equally unfair. To him, the fact that Murchison described the Upper and Lower Silurian Rocks in his original Silurian System in such a way that they can, to a certain extent, be recognized and

identified in Europe and America, is all-weighty. He calls special attention to the fact that Sedgwick's Upper Cambrian was ultimately found to possess the fossils of Murchison's Lower Silurian, but he forgets to add that it was Sedgwick, and not Murchison, who first gave the natural divisions of this group, placing them in their proper relations to each other, and defining their true limits above and below. He points out with emphasis the grand distinctions between the *Primordial* and *Second* Faunas, and the consequent impossibility of uniting the rocks they characterize in one and the same system; but the fact of the stratigraphical break at the base of the Mayhill Sandstone is, however, contemptuously dismissed as of no special classificatory value, and the two Llandoveryies are joined in a single formation. Thus, in one stroke, Sedgwick is deprived of his grand argument of a physical break between his own and the overlying rocks; and the *Second* and *Third* Faunas are re-united to form what is termed the Silurian System. In effect, Murchison receives the lion's share, simply on the ground of possession; while Sedgwick is deprived of half his system because he had the misfortune, in the earlier stages of the controversy, not to command so numerous and influential a following as his more socially fortunate opponent.

At irregular intervals, also, we catch a momentary glimpse of a stray individual who refuses to identify himself with either of these great parties; preferring rather to temporize by definitively assigning the rocks of the *Middle Fauna* to neither claimant in particular. He refers to them under such makeshift titles as the *Cambro-Silurian* or *Siluro-Cambrian*, according as his otherwise unexpressed personal bias inclines him to one or other of the contending parties. Occasionally, indeed, we do find him possessed of a true estimate of the grand importance of the group, but he often leaves it to be understood that he regards it as forming a transitional series of second-rate geologic significance; and, in effect, belonging properly to both Cambrian and Silurian at once. He is at the same time so fully impressed with the consciousness of his own forlorn and isolated condition, as well as of the hopelessness of stemming the current of vulgar use and wont, that he generally contents himself with simply recording his protest in this manner, and timidly guards himself against possible ambiguity and misconception by prefixing the qualifying term *True* or *Upper* when he comes to speak of the undisputed Silurian.

But, in addition to the foregoing, there are innumerable outsiders like myself, who care nothing for schools, but everything for the facts. There is that great and ever-increasing body of students who are attracted to the study of geology because of the flood of light it casts upon the mysterious problems of life and its distribution. Above all, there are those foreign geologists, who naturally expect from British investigators an authoritative and unmistakable geologic scale to which to refer the results of their own researches. To all these the crying scandal of this interminable dispute is an annoyance and a positive encumbrance.

But whose procedure shall we follow? Shall we adopt the Murchisonian's convenient plan of carrying down the base-line for

the Silurian System as far as a Trilobite has yet been detected, sinking it deeper and deeper into the earth as the progress of discovery reveals the evidence of the former presence of organisms in strata of yet older and older date, at the same time extending its highest boundary upwards into the supra-Ludlow formations as we detect the presence of an occasional fossil of a Ludlow type yet higher and higher in the more rapidly accumulated Red Sandstones above the *Bone beds*, till our unwieldy system includes half the fossiliferous sediments of the globe, and its very subdivisions are almost equal in classificatory importance to the accepted systems of a later date?

Or shall we adopt the methods of the traditional followers of Sedgwick, and, drawing a rigid line of demarcation at the base of the Lower Llandovery, imitate our opponents to the extent of erecting all the anterior fossiliferous strata into a gigantic system, on the ground that they were so combined by its founder, and in the delusive hope that we shall find at its base a universal unconformability, so that the name *Pre-Cambrian* will ever remain a synonym of the metamorphic and possibly azoic formations?

Or, with Lyell, shall we condone the past, and give a double share to the stronger party; consoling ourselves with the reflection that, after all, the question is merely a question of names, and not of principle; arguing that the injustice we tolerate did not originate with us, and is less the crime of a party than the inevitable result of untoward circumstance; and justifying our procedure in the eyes of the world by the implication that the general adoption of the larger portion of the Murchisonian nomenclature is already an accomplished fact, upon which it would be ridiculous to expect that any feeble efforts of ours would ever have the slightest influence?

Or, ought we rather to cast in our lot with the few who employ the term *Cambro-Silurian* or *Siluro-Cambrian* for the rocks of the *Second Fauna*, and try once again the oft-repeated and as oft-defeated experiment of reconciling the claims of both parties by allying the strata in dispute to two systems at once, in the use of titles which their very founders themselves abandoned as inconvenient and absurd?

Or, finally, standing aloof from all parties, shall we, in the name of science, claim the right of fully recognizing the systematic equality of the three Lower Palæozoic Faunas, by regarding the three successive rock-groups which contain them as individually entitled to the rank and denomination of a complete system?

It seems to me that to every unprejudiced mind it will be apparent that the adoption of this last course has now become an absolute necessity. Geologic truth and convenience imperatively demand a separate place and name for each of these systems. It only remains for us so to arrange their titles that no real injustice shall be committed.

Dr. Hicks's definition of the Cambrian system as including the *Paradoxides*- and *Olenus*-bearing beds, from the base of the Harlech Grits to the summit of the Lower Tremadoc is by far the best that has hitherto been proposed. Thus restricted, the title is synonymous

with that of the *Rocks of the First or Primordial Fauna* of Barrande, and is certain to be ultimately accepted everywhere among geologists, from its naturalness, geologic distinctness and convenience of application, not only in Britain and Western Europe generally, but also among the ancient rocks of the continent of America.

In the same way the general restriction of the title Silurian to the strata that are comprehended between the line marking the base of the Lower Llandovery, and that denoting the commencement of the brackish or fresh-water conditions of the typical Old Red Sandstone, appears equally inevitable. It covers the whole of the rocks of Barrande's *Third Fauna*, which, as we have seen, must be erected into a separate system as a matter of geologic convenience. It is fortunate that the application of Murchison's title to them has never been disputed, even by his bitterest opponent.

The various titles at present in use for the intermediate system are all certain to be discarded by the geologist of the future. They are all more or less erroneous, ambiguous, or inconvenient. The retention of the designation *Lower Silurian* would be as systematically erroneous as it is historically unjust. To call it *Upper Cambrian* would be to allow the followers of Sedgwick to commit the very error they so emphatically condemn in the procedure of their opponents. The perpetuation of the Sedgwick-Murchison controversy, by the general adoption of such a title as the *Cambro-Silurian* or *Siluro-Cambrian*—even were it possible—would be, to say the least of it, excessively unwise. Neither party is likely to forego its claims when the object of contention is so conspicuously labelled with the names of both.

Before, however, we can take a single step to free ourselves from the present difficulty, we must dispose of two formidable objections, which, under the guise of universally accepted scientific principles, have grown grey in the service of prolonging this unfortunate controversy, and have, as yet, stubbornly barred the way to anything like a peaceful solution.

By those who still retain the Silurian System of the later days of Murchison in all its magnitude, the argument of their founder that there is no universal stratigraphical break to be detected among the Lower Palæozoics, at least as far down as the base of the Lingula Flags, is held to be an overwhelming reply to all objectors. Similarly, it has been the habit for their opponents, in their turn, to point triumphantly to the local breaks in Britain between the Mayhill and Bala beds, as affording in themselves a positive demonstration of the truth of their own view that these formations belong to wholly distinct systems. For a corresponding reason, also, the latter party claims for the Cambrian all the fossiliferous strata that underlie the Llandovery, from the fact that the physical succession among them is uninterrupted by a general physical break. Of such pre-eminent value is this principle considered, even by those who profess to stand aloof from this controversy, that a strong tendency is abroad to sacrifice in its favour the Old Red Sandstone itself.

To the field-geologist, pure and simple, who desires, above all

things, an unmistakable base-line for his system, capable of being rigidly defined upon his maps and sections, the presence of a decided unconformability affords the very thing of which he stands most in need. The grouping founded upon stratigraphical breaks commends itself to his mind with a force that is practically irresistible. But it is far otherwise with the cautious systematist, who endeavours to found his systems in accordance with those of Nature herself, upon principles, not of local, but of universal application. Though fully cognizant of the value of an unconformability as affording him a fairly reliable horizon within a limited area, he soon learns that it is of all things most untrustworthy when it extends over regions of large diameter. It is at most a local phenomenon, wholly misleading except in local application.

It is surely a work of supererogation in these days to point out how the tendency of the entire course of geological discovery for the last fifty years has been to reduce to a mere shadow the magnitude of the miraculous and world-wide stratigraphical breaks that bounded the geologic systems of our forefathers. The doctrine of universal convulsion and the simultaneous destruction of all the life upon the earth at the end of each great epoch has so long since passed into the limbo of exploded hypotheses, that it would be highly amusing, were it not so painful, to see its degenerate and impoverished survival—the dogma of the necessity for general stratigraphical and palæontological breaks between our modern systems—dragging out its miserable and ridiculous existence, even in our midst, and claiming allegiance from men of standing in the science.

One concession, and one only, appears to be all that is needful to meet the real facts of the case. As a general rule, our British systems have been founded, less upon palæontological than upon mineralogical considerations, and it is more of the nature of a series of happy accidents, than a geologic necessity, that they happen to possess such distinctive faunas. In all cases, however, it is clear, both here and elsewhere, that the faunas that characterize our accepted rock-systems owe their distinctness—such as it is—to the fact that in the more typical areas there happened to be an absence of fossiliferous strata to unite them. Whether the time thus zoologically unrepresented was occupied in the upheaval and partial denudation of the rocks of the preceding system (as locally between the so-called *Lower* and *Upper Silurians* of Britain), or whether, on the other hand, it was filled by the deposition of barren strata (as between the corresponding systems of the United States), the result is precisely the same. The faunas of the consecutive systems differ to the extent of the progress made in the locally unrepresented interval; and the group of rocks holding each fauna forms for the geologist a convenient Procrustean bed to which to fit the tolerably synchronous deposits of other lands. The unconformability argument is worthless except from the point of view that the faunas of our typical British systems are likely to be the more distinct the longer these separating interregnums lasted. It is best, that is, simply as a matter of convenience and clearness of definition, to

choose, if possible, the longest non-fossiliferous periods to divide them, and these are almost certain to occur where there is the greatest appearance of unconformability.

Nevertheless, the same effect may be owing to a cause in its nature diametrically opposite—the required palæontological break being due to a more than ordinary depression of the sea-bed, and the consequent cessation of almost all deposition in that area—a circumstance to my mind of equal importance from a classificatory point of view with an unconformability itself. An extraordinary regional depression of this character seems to have been the actual cause of the apparently sudden change in the facies of the Palæozoic fauna at the commencement of the Arenig period, both in Britain and Scandinavia, and when fully worked out will, in all probability, enable us to lay down a palæontological line of demarcation far more strictly synchronous throughout its geographical range than that which we shall be compelled to adopt at the base of the Lower Llandovery.

Nor is the venerable objection—that, owing to the established laws of scientific nomenclature, a moral obligation is binding upon us to adhere rigidly to the limits of each system as originally laid down by its founder—worthy of a whit more respect.

This is a claim whose absurdity verges upon the ridiculous when it is advanced by the Murchisonian in support of his contention that the *Paradoxides* and *Olenus* beds appertain to the Silurian, for they actually antedate all the strata of Murchison's original *Silurian System*. It is, therefore, only occasionally employed by him in a restricted sense in defence of his retention of the strata of the *Second Fauna*.

It crops up continually, however, in the writings and arguments of those belonging to the opposite party. It is urged again and again with a wearisome iteration, as if this conservative rule in geologic nomenclature were necessarily to over-ride every other scientific canon whatsoever. But even if we grant that Sedgwick, and not Murchison, first correctly defined and characterized the rock-group which yields the *Second Fauna*, this rule is equally inoperative in the face of our present recognition of the grand geological importance and distinctness of this *Fauna*. Of this fact Sedgwick was originally wholly unaware; nor does he ever appear to have estimated it at its true value. To us, however, who have watched the gradual elimination of the *Primordial Fauna*, the grand distinctness of the *Second Fauna* is so glaringly apparent, that it is impossible for us to conceive of the rock-group which it characterizes as a mere subdivision of the Cambrian.

It is all very well to plead for historic justice, and to demand, out of respect to the memory of a genius, the adoption of the nomenclature which the general geological world was, in a sense, deprived of the opportunity of accepting during his lifetime. But time and geological convenience will soon make short work of any scheme of nomenclature, however historically just, if it be not in all its parts the natural expression of the inter-relationships and mutual subordination of the facts it is its special aim to associate and systematize.

No amount of enthusiastic regard for the memory of a martyr will bolster up an unwieldy system for ever. The giant size upon which its weaker advocates pride themselves must in the end be the main cause of its inevitable dismemberment. We shall best promote the interest of the man whose memory we venerate, by modestly claiming for him as much, and no more, than truth and geological convenience will allow.

Thus, however reluctant we may be to interfere with the schemes of classification propounded by our great masters in the science, it appears to me that the time has now arrived when we can no longer be accused of disrespect or disloyalty in endeavouring to emancipate ourselves from the inconveniences due to our superstitious adherence to an effete and unworkable nomenclature. The present needs of our science demand, with a unanimous voice that partizanship can no longer silence, a distinct title for the rocks of the *Second Fauna*. The experiment of naming them in such a way as to recognize the claims of both Murchison and Sedgwick has been tried again and again with the same result. It has invariably ended in prolonging and greatly intensifying the original controversy. But one course remains to us. We must give it a new title, which, though it might have been originally suggested by either party, shall contain no element of future discussion.

So long as present systems of nomenclature survive, nothing can disturb the application of the title of Cambrian to the rocks of the *Primordial Series*, and that of Silurian to the strata of the *Third Fauna*. In these systems, as thus restricted, the most perversely ingenious partisan could scarcely find room for controversy. Within these limits the labours of their respective founders were comparatively perfect and complete, and the propriety and harmony of their original classifications, though slightly modified in detail by subsequent research, has never been impugned, either by friend or foe. It is vastly different, however, as we have seen, with the intermediate system. From the day it was recognized until now, it has been the object of incessant disputes. Its co-discoverers both committed the gravest of errors regarding either its proper limits, its relationships, or the sequence and fossils of its component formations. It has been the subject of almost as much passionate argument as the Wernerian theory itself; and the whole subject is a disgrace to modern science, and an obstacle to its progress that must be got rid of—whatever the sacrifice.

Time has already done justice to the value of the discoveries of both Murchison and Sedgwick, by assigning them each a system in which their labours were accurate and complete. We shall do their memories the greatest service by giving the system in which their work appears to our eyes—in the light of later discovery—to have been more or less inaccurate or deficient, a title which shall bear no personal reference to either.

Sedgwick, with his well-balanced and philosophic mind, named his system after the entire Principality in which his rocks were typically developed. His title of Cambrian is thus comprehensive

enough to embrace the whole of the Lower Palæozoics. It not only calls up before the imagination the majestic mountains where they may be studied under their most typical aspect, but it reminds us that they formed the fortress-homes of the early Britons—those proud old savages, who, like the *Greywackés* upon which they trod, were the last to succumb to the irresistible march of conquest.

Murchison, on the other hand, with his military proclivities, and a keener instinct for locality, had already made choice of the term Silurian; associating the rocks of his system with that classic Cambrian tribe, the *Silures*, whose indomitable struggles for liberty had hallowed the very hills upon which he sought his types; and thus, in a measure, he may be said to have erected an everlasting monument to British valour and love of freedom.

But, as has been more than once pointed out elsewhere, the *Silures* were a nation inhabiting the southern parts of Wales, and Murchison distinctly availed himself of the privileges of genius in thus extending their rule into Shropshire and the regions to the north.

North Wales itself—at all events the whole of the great Bala district where Sedgwick first worked out the physical succession among the rocks of the intermediate or so-called *Upper Cambrian* or *Lower Silurian* system; and in all probability much of the Shelve and the Caradoc area, whence Murchison first published its distinctive fossils—lay within the territory of the *Ordovices*; a tribe as undaunted in its resistance to the Romans as the *Silures*. It was indeed the last of the old British tribes to yield to their invincible legions; and it is consequently quite as well worthy of scientific commemoration as the *Silures* themselves.

Camden thus refers to the *Ordovices*:¹ “Those countries of the *Silures* and *Dimetæ*, which we have last surveyed, were in after-times, when Wales came to be divided into three Principalities, called by the natives Deheubarth (or the Right-hand part), and in English, as we have already observed, South Wales. The other two Principalities (which they call Gwynedh and Powys, and we North Wales and Powisland) were inhabited by the *Ordovices*, called also *Ordevices*, and *Ordovicæ*, and in some authors, though corruptly, *Ordulucæ*. A courageous and puissant Nation these were, as being inhabitants of a mountainous country; and receiving vigour from native soil; and who continued, the longest of any, unconquered either by Romans or English. For they were not subdued by the Romans till the time of the Emperor Domitian; when Julius Agricola subdued almost the whole nation. Nor were they subjected by the English, before the reign of Edward the First. For a long time they enjoyed their liberty, confiding as well in their own strength and courage, as in the roughness and difficult situation of their country, which seems to be laid out by Nature for ambuscades and the prolongation of war. To determine the limits of these *Ordevices* is no hard task, but to give a true reason of the name seems very difficult. However, I have entertained a notion, that, seeing they were seated upon the two rivers of Devi, which springing

¹ Camden's *Britannia*, Dr. Gibson's Translation, second edition, p. 778.

not far asunder, take their course different ways, and that *Oardevi* (Read *Ar-dhyvi*—Transl.) in the British language signifies—Upon the rivers of *Devi*—they have been thence called *Ordevices*. To the *Ordevices* belonged those countries which are now called in English by new names—Montgomeryshire, Merionethshire, Caernarvonshire, Denbighshire, and Flintshire.”

Here, then, have we the hint for the appropriate title for the central system of the Lower Palæozoics. It should be called the **ORDOVICIAN SYSTEM**, after the name of this old British tribe.

Whatever arguments may be adduced in support of the term *Silurian* will apply equally well, or even with greater force, to this new title. Like the term *Silurian*, it is classic in origin, but at the same time thoroughly British. It is equally euphonious, and far more strictly significant of the geographical area where its strata are typically developed. Indeed, the employment of the one title almost of itself necessitates the adoption of the other; for only in this way is it possible to recognize the systematic equality of the two systems in their very designations—the one receiving its name from the ruling tribe in the *south* of Wales, the other from the dominant tribe in the *north*. If there is anything specially becoming in commemorating the warlike tribe of the *Silures* in the name of a geologic system, how strikingly appropriate is the title of *Ordovician* in erecting a similar scientific monument to the last and most valiant of the old Cambrian tribes.

On this arrangement the Lower Palæozoic Rocks of Britain stand as follows:—

- (c) **SILURIAN SYSTEM**:—Strata comprehended between the base of the *Old Red Sandstone* and that of the *Lower Llandovery*.
- (b) **ORDOVICIAN SYSTEM**:—Strata included between the base of the *Lower Llandovery* formation and that of the *Lower Arenig*.
- (a) **CAMBRIAN SYSTEM**:—Strata included between the base of the *Lower Arenig* formation and that of the *Harlech Grits*.

That our attempt to cut in this way the knot which all the schools have already convinced both themselves and others of the utter impossibility of untying, will do much more than draw the attention of geologists in general to what we believe to be the more striking aspects of the question, can hardly be expected. It is almost certain that any suggestion that might have been made by either of the schools with the object of freeing this section of the science from the present dead-lock, would, as a matter of course, be opposed to the utmost by the others. How much worse is it when the hint is given from without. The great mass of the most influential of our living geologists have so long since given in their adhesion to one or other of the contending parties, that it is not improbable that our well-meant interference will be stigmatized by all as a most unwarranted and impertinent intrusion.

By those, however, who are weary of the interminable discussion, and who feel the necessity for some scheme of classification which, while it systematizes the known facts, holds the balance true with reference to the opposing claims of the two great pioneers in the

study of the Lower Palæozoics, our suggestion may be tolerated now, and adopted later on, when the necessity for this course has become more strikingly apparent. To those who interest themselves in the attempted correlation of the Lower Palæozoic Rocks of the Northern Hemisphere, and who are continually hampered by the want of some clear and unmistakable generic terms expressive of the general parallelism among these widely-separated deposits, the ease and comfort of a classification which imitates Nature herself in placing the three grand members of the Lower Palæozoic Rocks upon an equal footing, is an advantage of which they are certain in time to avail themselves to the full. Those again, who feel how vain is the endeavour to parallel the special formations and minor stages of our British Lower Palæozoics with those of other areas, will hail with some approach to satisfaction the release of such convenient sub-generic terms as *Lower* and *Upper Cambrian*, and *Lower, Middle, and Upper Silurian*, with the list completed by the addition of *Lower* and *Upper Ordovician*;—terms all of easy and immediate application, and all expressive of epochs, which, so far as our present knowledge enables us to judge, embrace tolerably equal periods of geological time.

No earnest student of the history of discovery among the Lower Palæozoic Rocks, whose opinions are the natural outcome of his own careful generalization of presently known facts, and not the petrified remains of the views he so enthusiastically adopted a quarter of a century ago, can fail to perceive that the ideas of the extreme party which claims all the Lower Palæozoics for the Silurian are fated soon to become wholly extinct. The wave of backward opinion which led this party to revert in substance to the ideas of their predecessors was inevitable. We are now witnessing the as-inevitable return of the tide. Here and there this application of the term may linger on for a time, as in Bohemia, and possibly in Scandinavia, kept alive by the very principle that must in the end prove fatal to it, when local conveniences become superseded by cosmopolitan necessities.

A single glance at the magnificent development of the Lower Palæozoics on the continent of North America is enough to convince every unbiassed investigator how much we have yet to learn regarding their British prototypes, and how ridiculously inadequate is our present estimate of their grand importance in the geological series. As this knowledge dawns upon us as the result of our discoveries in the future, some such classification as is here proposed will perforce be adopted by all; and the systematist will then be left free to work out his generalizations untrammelled by the defects of a cramped and unnatural nomenclature. Our British strata can in the end return but one answer to the most extended appeal. Every geologist will at last be driven to the same conclusion that Nature has distributed our Lower Palæozoic Rocks in three sub-equal systems, and that history, circumstance, and geologic convenience, have so arranged matters that the title here proposed for the central system is the only one possible.
